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DEVELOPMENT OF A METHODOLOGICAL FRAMEWORK FOR ASSESSING THE RESILIENCE OF SOCIO-ECONOMIC SYSTEMS IN THE CONTEXT OF SUSTAINABLE DEVELOPMENT

The object of research is the methodological foundations for assessing the level of resilience of the socio-economic system in the context of sustainable development management. The main problem focused on in the research is determining the economy's ability to adapt to external and internal shocks in order to minimise their impact and ensure sustainable development. The proposed macroeconomic resilience index (MRI) is constructed using content analysis, systemic, index and quantitative approaches. The developed system for assessing the macroeconomic resilience index covers 18 indicators, which are grouped into four dimensions of resilience: economic, environmental, social and institutional. A sub-index is calculated for each dimension, which allows for a decomposition analysis of the adaptive potential of each area of management. The proposed four-level scale for assessing the resilience of the socio-economic system allows for a quantitative assessment of its state and the identification of vulnerable areas of management. The scale defines a specific state of the system: critical vulnerability; fragile adaptability; moderate; adaptive, and systemic resilience. The use of the macroeconomic resilience index (MRI) methodology allows assessing the ability of the socio-economic system to adapt, recover and maintain viability in crisis conditions. Applying the proposed methodology to assess Ukraine's case in the period 2019–2023, it was found that the socio-economic system on the resilience scale ranges from a state of vulnerability MRI = 0.26 to adaptive resilience MRI = 0.68. It has been established that the social and environmental spheres are critically vulnerable areas for the recovery of the socio-economic system. Meanwhile, the economic and institutional spheres formed the foundation of the resilience of the Ukrainian macroeconomy. The proposed assessment system provides a basis for developing practical recommendations for strengthening adaptive capacity and supporting the resilience and sustainability of socio-economic systems.

Keywords: *macroeconomic resilience index (MRI), socio-economic inequality, resilience of socio-economic systems, resilience scale, sustainable development.*

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1. Introduction

Modern socio-economic systems operate in an environment with a high level of uncertainty, which is caused by global crises, economic recessions, pandemics, climate change and military conflicts. In such conditions, resilience as the ability of systems to adapt, recover and develop becomes a determining factor in their stability and competitiveness. Research into the resilience of socio-economic systems helps to identify mechanisms that allow society and the economy to recover faster from crises and minimize the negative consequences of exogenous shocks and endogenous shocks. A deep analysis of this problem allows to identify key factors of resilience, develop methods for assessing the impact of these factors, which will help the socio-economic system adapt to new conditions. This is especially relevant for countries facing hybrid threats and serious socio-economic and geopolitical challenges.

Resilience is considered by the authors as an interdisciplinary concept that encompasses not only natural but also socio-economic systems. The ability to quickly and effectively restore previous or certain levels of productivity after unforeseen destructive events is known as resilience [1].

Modern research in the field of determining the resilience of microeconomic systems identifies three key areas that develop relatively independently of each other:

– effective use of the strengths of the company's personnel [2];

– flexibility and adaptability of business models, in particular digitalization tools [3];

– creation of sustainable and resilient supply chains and logistics [4].

The study [5] analyzes the key factors influencing the development of digital transformation in Ukraine. It is established that technological and behavioral factors have a decisive impact, encouraging market operators to actively adapt to changes in the external environment and introduce innovations into their business models. In contrast, socio-economic and institutional factors have a much smaller impact on innovation processes in the retail sector.

The analysis of scientific discourse has led to the conclusion that the resilience of a socio-economic system means its ability to absorb shocks, adapt to changes and restore its functions after a period of instability or crisis. A resilient system has the internal potential to recover and develop further even after the impact of shocks or disasters.

At the national level, the creation of a favorable business environment is a key factor in strengthening macroeconomic resilience [6]. In particular, the development of entrepreneurship contributes to increasing the ability of the economy to adapt and recover from external shocks. Price regulation can both exacerbate crisis phenomena and slow down the process of economic recovery.

Resilience is usually understood as the ability of a system to maintain stability and return to its original state after being disrupted by an external shock. This term is mainly used to describe how an economy responds and adapts to external factors [7]. In [8] it is argued that resilience is largely about learning to change, not about changing. That is, trying to protect a system by keeping it in a constant state reduces its resilience. Sometimes a managed transformation of a system is necessary so that it can continue to provide what is of fundamental value to society.

In this context, resilience is seen as the ability of a system, society or community facing risks to sustain, perceive and adapt to them, and to recover from the consequences of risks in an effective and timely manner, including by preserving and restoring its fundamental structures and functions [9]. Thus, resilience is a useful concept that goes beyond social and natural concepts and is increasingly used in economic policymaking.

According to [10], macroeconomics is constantly affected by socio-economic shocks and the concept of resilience was developed to predict these shocks, reduce losses and recover quickly. Therefore, research is aimed at a quantitative approach to the analysis of macroeconomic resilience to socio-economic shocks and suggests appropriate measures to increase resilience.

In the current conditions of the VUCA world (volatility, uncertainty, complexity and ambiguity), the concept of resilience has become an integral part of research at all levels of socio-economic systems, including regional and global economies [11]. In addition, resilience has a significant impact on the formation of political decisions, in particular in the context of new imperatives for economic recovery after the impact of global or regional challenges and threats.

In many cases, the resilience of a socio-economic system to crises and its ability to recover depends on a number of endogenous factors. Such factors include: the flexibility of markets, the effectiveness of government, the expectations of consumers and investors, the level of diversification of production and financial reserves. The presence of a positive impact of these factors explains why some economic systems demonstrate rapid recovery even after serious shocks, such as financial crises, pandemics or geopolitical conflicts.

An important aspect of resilience research is its measurement. The authors of [12] conducted an analysis of 27 empirical studies on the validation of resilience indicators. The study showed that the choice of indicators for measuring resilience should meet the criteria of objectivity and repeatability for different local and contextual conditions.

For example, the eight-dimensional resilience index developed by [13] accurately determines the resilience and vulnerability of countries around the world. All versions of this indicator lead to similar conclusions. Countries with rich natural resources will be more resilient to the threat of a crisis. Conversely, apparently successful countries, which advanced economic development (high GDP per capita), allows them to import natural resources from foreign countries will be more vulnerable in the long term.

In [14], a holistic index of countries' resilience to global pandemics (Holistic Resilience Index, HRI) was developed. This index is a comprehensive indicator that combines 11 different indicators grouped into 5 main categories. The author assessed the resilience of countries to pandemics using two approaches: expected resilience at a certain point in time and the dynamics of changes over time. The index takes into account only changes in indicators, and not their absolute values (i. e., how a country improves or loses its resilience). This approach allows for the analysis of both the current state of preparedness and trends in changes in the long term.

The factual assessment proposed by [15] is based on changes in the main indicators: in the economy, this is the dynamics of production, in the ecology, the level of environmental pollution, in the social sphere, the spread of poverty. Forecast assessments based on the same indicators are implemented through a multi-scenario approach, which allows for the development of preventive measures.

Another important aspect is monitoring changes in resilience, which allows for the assessment of both progress and regression in the resilience of a system [16]. This requires having baseline data on the state of the system before or after the impact of a shock, as well as defining a reference point against which changes will be measured.

Assessing resilience according to the approach [17] takes into account such aspects of the phenomenon as economic independence, education and skills, financial resilience, governance, productive capacity, and social progress and cohesion.

Although the evolutionary approach to resilience is valuable, it is usually difficult to measure [18]. For this, methods based on equilibrium are used, including estimating the time needed to recover and the ability to avoid losses after a shock. At the same time, it can be argued that this approach is a more accurate indicator of economic efficiency than traditional indicators, for example, economic growth, since it reflects the ability of the economic system to maintain resilience in the long term, which is a key criterion for its success.

Various approaches and methods of strengthening resilience at the macroeconomic level are associated with achieving appropriate results through stimulating innovative processes, mechanisms and cycles, as well as by increasing the efficiency of the education system, in particular vocational and technical [19].

In [20], it was investigated how a change in the elasticity of substitution between value added and intermediate factors of production affects total economic output and, accordingly, fluctuations in business cycles. It was established that if enterprises can more flexibly substitute factors of production, the economy becomes less vulnerable to local shocks. On the contrary, if substitution is complicated, the consequences of individual crises can have a stronger impact on the entire macroeconomic output, increasing the amplitude of business cycles. In [21], it is concluded that businesses with well-coordinated work processes are more productive. However, such business units are more vulnerable to unexpected staff turnover, which forces them to develop special strategies to minimize risks. In addition, coordinated companies suffer more from global economic shocks.

Thus, modern research on the resilience of socio-economic systems is focused on developing methodological approaches to its assessment, analyzing theoretical aspects and identifying factors that contribute to increasing the ability of systems to resist and adapt to external shocks.

Along with this, some issues remain insufficiently addressed in the modern scientific literature. First, there is a lack of comprehensive methodological approaches that can be applied to assess the resilience of socio-economic systems, especially in economies experiencing prolonged crises. Secondly, existing research focuses mainly on individual recovery indicators, while systemic vulnerabilities and adaptive capacities of socio-economic systems in the context of achieving the Sustainable Development Goals are not given enough attention. Thirdly, there are few works that would conduct empirical studies of the proposed methodologies for measuring resilience in the context of socio-economic systems of countries facing simultaneous geopolitical, economic, environmental and social shocks, such as, for example, Ukraine.

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The object of research is the methodological foundations for assessing the level of resilience of the socio-economic system in the context of sustainable development management.

The aim of the research is to theoretically substantiate and develop a methodological approach to assessing the resilience of socio-economic systems at the macroeconomic level.

To achieve the set aim, it is necessary to solve the following objectives:
– develop a resilience scale to assess the level of vulnerability of the socio-economic system;
– apply the proposed methodology to assess the macroeconomic resilience of Ukraine and identify vulnerable areas of its measurement;
– identify priority areas for strengthening resilience within the framework of a sustainable development strategy.

2. Materials and Methods

Assessment of the resilience of socio-economic systems and its components is a key stage in determining priorities to ensure the preservation of the development potential of this system. Macroeconomic resilience is considered by the authors of the article as the ability of a socio-economic system to be viable, adapt to shocks, support sustainable development and ensure effective recovery after crises on the principles of sustainable development. This requires a new scientific and methodological approach, which includes successive stages: selection of appropriate indicators, collection of necessary data and application of methods for calculating indicators and generalizing indicators. For this purpose, the research design is built using the following methods: content analysis, system approach, multifactor analysis, expert assessments, min-max normalization for data standardization, index and graphical methods.

Content analysis was used during desk research of open sources to generate reliable statistical data. The methodology for assessing macroeconomic resilience was based on a systematic analysis of key dimensions, covering economic, environmental, social and institutional aspects. The key problem under study is to determine the ability of the socio-economic system to adapt to external and internal shocks, to minimize their impact and ensure sustainable development. Accordingly, each dimension assesses resilience from a certain perspective.

The selection of indicators was carried out by analyzing international indices, macroeconomic factors and expert assessments. The selection of indicators was carried out on the basis of expert assessments according to the following criteria: representativeness, accessibility of open statistical data. The expert survey was conducted using the Delphi method. The group was formed of 15 experts, which included scientists in the field of economics and management with at least 10 years of professional experience and experience in analytical and project activities. Experts were asked in an anonymous survey to select from 20 proposed, the most significant indicators that determine the stability of the socio-economic system and to determine the importance of each component of the resilience dimension (economic, environmental, social and institutional). With a high degree of consistency of opinions (Kendall concordance coefficient 0.83), 18 indicators were selected across four dimensions.

Economic resilience reflects the level of resilience of macroeconomic development after the impact of shocks and crises. The main indicators selected to assess economic resilience at the macroeconomic level: X_1 – GDP per capita (USD per capita, in basic 2019 prices); X_2 – annual economic growth indices (index); X_3 – index of economic freedom (index); X_4 – level of external debt (%); X_5 – level of investment in fixed capital (%).

Ecological resilience assesses the ability of a socio-economic system to maintain a balanced use of natural resources and ensure sustainability with minimal negative impact on the environment. The authors proposed the following main indicators for assessment: X_6 – level of greenhouse gas emissions per capita (coefficients); X_7 – share of renewable energy in total energy consumption (%); X_8 – degradation of land resources (%); X_9 – share of the population with access to drinking water (%); X_{10} – ecological footprint per capita (global hectares (gha) per capita).

Social resilience characterizes the ability of society to maintain its potential for functioning and recovery despite the risks of social tension. The following indicators were used to assess it: X_{11} – unemployment rate (%); X_{12} – demographic situation (demographic burden index); X_{13} – availability of social protection (social security index); X_{14} – level of income inequality (Gini coefficient, %).

Institutional resilience is considered by the authors as the ability of state institutions to ensure manageability, transparency and predictability of the institutional environment, which is a component of the resilience of the socio-economic system. In this context, the following assessment indicators are used: X_{15} – quality of public administration (government efficiency index); X_{16} – independence of the judiciary (rule of law index); X_{17} – political stability (political stability index); X_{18} – perception of corruption (corruption perception index).

Since each dimension of macroeconomic resilience is assessed on the basis of the corresponding indicators (X_1–X_{18}), this allows to obtain specific sections that provide an idea of the components of the system under study. For each dimension, a partial indicator is calculated – a sub-index that aggregates the indicators that form it.

To calculate the partial indicators of the assessment system and the integral indicator of macroeconomic resilience, an index method was used. As a result, four sub-indices were identified: Economic Resilience Index (*EcRI*), Environmental Resilience Index (*EnRI*), Social Resilience Index (*SRI*) and Institutional Resilience Index (*IRI*).

At the next stage, each indicator (X_1–X_{18}) included in the sub-indices is normalized. For this, the min-max normalization formula was used

$$X^j_{i\,norm} = \frac{X^j_i - X_{min}}{X_{max} - X_{min}}, \quad (1)$$

where X^j_i – the actual value of the j-th indicator in the i-th resilience criterion, revealing one of the aspects: economic, environmental, social or institutional; X_{max} and X_{min} – respectively, the minimum and maximum value of the j-th indicator in the data set.

As is known, min-max normalization allows to bring indicators of different scales and units of measurement to a single form on a scale from 0 to 1. It allows to compare different indicators with each other, analyze and process data for further research purposes.

The calculation of the resilience sub-indices of the socio-economic system (K_iRI) was carried out on the basis of the average values of the normalized indicators according to the formula

$$K_iRI = \frac{\sum_{n=1}^{j} X^j_{i\,norm}}{\sum j}, \quad (2)$$

where K_iRI – sub-indices that assess the resilience of the socio-economic system corresponding to the i-th criterion (K_1 – economic, K_2 – environmental, K_3 – social or K_4 – institutional aspect); j – the corresponding indicator that forms the i-th resilience criterion.

At the last stage, the integral Macroeconomic Resilience Index (*MRI*) is calculated as the weighted average value of all four sub-indices. For this, weighting coefficients are used that determine the relative importance of each component of the resilience dimension (economic, environmental, social and institutional). They are established based on the results of expert assessments, the actual value is:
– economic resilience $w_1 = 0.3$;
– environmental resilience $w_2 = 0.2$;
– social resilience $w_3 = 0.2$;
– institutional resilience $w_4 = 0.3$.

To calculate the final integral index, the formula is used

$$MRI = \frac{EcRI \cdot w_1 + EnRI \cdot w_2 + SRI \cdot w_3 + IRI \cdot w_4}{w_1 + w_2 + w_3 + w_4}, \quad (3)$$

where w_1, w_2, w_3, w_4 – weighting factors that determine the relative importance of each resilience component; *EcRI* – Economic Resilience Index; *EnRI* – Environmental Resilience Index; *SRI* – Social Resilience Index; *IRI* – Institutional Resilience Index.

The calculated final index, represented by formula (3), allows to obtain an overall assessment of the country's macroeconomic resilience, taking into account the identified aspects of economic, environmental, social and institutional resilience.

For further evaluation of the research results, a five-step scale using the equidistant step method is proposed, which allows to determine the levels of macroeconomic resilience and provide an interpretation for each of them. Table 1 shows the criterion values of the *MRI* integral index according to the proposed scale.

The constructed measurement scale in Table 1 allows to objectively assess the level of macroeconomic resilience of the country according to the proposed criteria and determine the ability of the socio-economic system to counteract challenges and crises. The proposed five-step scale allows to classify socio-economic systems according to their level of resilience, which subsequently creates a methodological basis for further development of strategies to increase resilience.

3. Results and Discussion

The post-war recovery of Ukraine and ensuring sustainable socio-economic development directly depend on the level of macroeconomic resilience as the ability of the national economy to adapt to crisis phenomena, maintain stability and quickly recover after shocks.

The proposed methodological approach to assessing the resilience of the socio-economic system was tested using macroeconomic data of Ukraine for the period 2019–2023. To determine the level of macroeconomic resilience of Ukraine, the data were systematized and grouped, which are presented in Table 2 [22–37].

The data in Table 2 were used as the primary basis for calculating the normalized values for all indicators (X_1–X_{18}) included in the macroeconomic resilience assessment system. The calculated values of the normalized values of the indicators according to formula (1) were aggregated into sub-indices (2) the results are shown in Fig. 1.

Table 1

Scale for interpreting the results of the Macroeconomic Resilience Index measurement

MRI	Level	Interpretation
0–0.2	*Critical vulnerability*	Characterizes high vulnerability to crises and critically low system adaptability and its ability to recover
0.21–0.4	*Unstable adaptability*	Demonstrates low system resilience to crises. Indicates slow adaptation rates with high cost and long recovery time
0.41–0.6	*Moderate resilience*	Characterizes moderate stabilization of the socio-economic system, when existing compensation and adaptation mechanisms have a short-term effect
0.61–0.8	*Adaptive resilience*	Demonstrates the system's ability to recover quickly. Indicates a relatively stable ability to adapt to crisis situations and maintain sustainable economic viability
0.81–1.0	*Systemic resilience*	Demonstrates high system adaptability and its ability to minimize the consequences of the crisis, recover quickly, and ensure sufficient rates of sustainable development

Table 2

Calculated data for the index assessment of macroeconomic resilience, 2019–2023

Criterion	Indicators	2019	2020	2021	2022	2023
Economic resilience (*EcRI*)	X_1: GDP per capita (in base 2019 prices calculated using [29, 31])	3661.5	3573.1	4327.9	3285.9	3894.1
	X_2: Annual economic growth indices [30]	103.2	96.2	103.4	71.2	105.3
	X_3: Index of economic freedom [26]	6.24	6.16	6.17	6.06	6.17
	X_4: Level of external debt [29]	79.2	80.8	64.9	81.5	90.4
	X_5: Level of investment in fixed assets [28]	3.81	–0.56	3.35	0.71	2.38
Environmental resilience (*EnRI*)	X_6: Level of greenhouse gas emissions (calculated using [22, 23])	0.059	0.054	0.055	0.029	0.032
	X_7: Share of renewable energy in total energy consumption [24]	8.0	11.0	13.0	10.0	10.0
	X_8: Degradation of land resources [25, 37*]	20.0	21.8	22.4	25.0	33.0*
	X_9: Share of population with access to drinking water [32]	88.0	88.0	88.0	88.0	88.0
	X_{10}: Ecological footprint per capita [25]	2.80	2.06	2.21	2.01	2.01
Social resilience (*SRI*)	X_{11}: Unemployment rate [33]	8.2	9.5	9.8	21.1	18.2
	X_{12}: Demographic situation [31]	48.4	49.1	54.1	49.0	54.3
	X_{13}: Availability of social protection [32]	66.86	71.21	71.56	71.51	70.47
	X_{14}: Level of inequality revenues [35]	26.6	25.6	26.0	25.0	25.0
Institutional resilience (*IRI*)	X_{15}: Quality of public administration [27]	29.6	37.9	37.9	33.8	32.0
	X_{16}: Judicial independence [36]	31.5	42.2	41.1	31.4	31.0
	X_{17}: Political stability [36]	8.96	12.26	12.74	6.13	10.9
	X_{18}: Perception of corruption [34]	30.0	33.0	32.0	33.0	36.0

Note: generalized by the authors based on data from [22–37]

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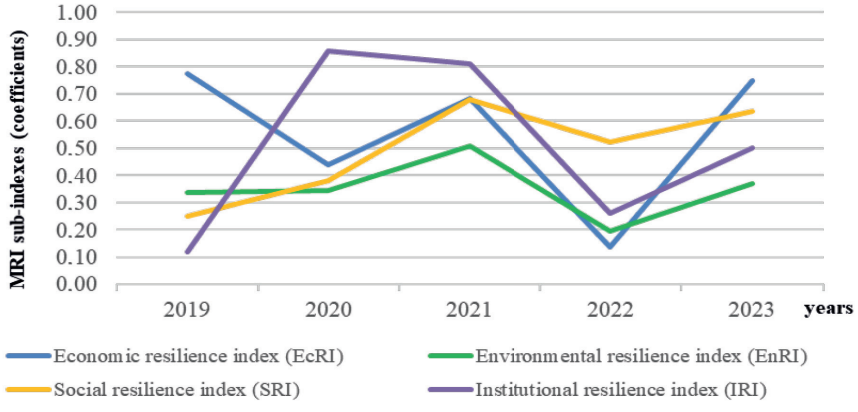

Fig. 1. Sub-indices of macroeconomic resilience of Ukraine (coefficients)

The calculated values of the sub-indices shown in Fig. 1 were formed under the influence of the dynamics of the indicators defined in Table 2. Thus, the economic resilience of Ukraine in 2019–2023 underwent significant fluctuations associated with both internal factors and the impact of external crisis phenomena. During the period under study, there was uneven national production, as evidenced by fluctuations in GDP per capita (X_1), calculated in basic prices of 2019. Fluctuations in economic growth rates (X_2) demonstrated a significant impact on the economy of both external and internal factors. The indicator of the level of external debt (X_4) increased during the analyzed period, which indicates an increase in the country's debt obligations. The level of investment in fixed assets (X_5) was sensitive to economic uncertainty and crises in 2020 and 2022 and some resilience and revival of economic activity in 2021 and 2023. In general, Ukraine's economic resilience showed peak lows in 2020 and 2022, which corresponded to shocks associated with the COVID-19 pandemic and the war.

According to the analysis, Ukraine's environmental resilience challenges have, according to the proposed scale, the greatest vulnerability. Thus, the reduction of greenhouse gas emissions (X_6) and the ecological footprint (X_{10}) is a positive aspect, but it mainly indicates a decline in the level of production, rather than progress in the environmental aspect. The growth in the share of renewable energy (X_7) is evidence of a decrease in dependence on traditional energy sources, but this share remains low compared to other countries, which indicates the need for changes in the energy sector. The problem of land degradation (X_8), which increased quantitatively from 20% to 33% during the analyzed period, significantly affects the entire food chain of the country and remains an unresolved challenge for sustainable development.

The researchers found that Ukraine's social resilience in 2019–2023 had paradoxes that did not coincide with the dynamics of economic and environmental sustainability. Along with this, the negative impact of both the pandemic and the war is clearly visible on the *SRI* curve shown in Fig. 1. The unemployment rate (X_{11}) is growing rapidly in 2022, reaching 21.1%, compared to 8.2% in 2019, which is a consequence not only of the economic crisis, but also of the destruction associated with the war. In 2023, every sixth Ukrainian from the group of the active population was unemployed, which had a significant negative impact on the resilience of the socio-economic system. However, the main problem of Ukraine during the war and will be after its end is the demographic crisis. The demographic situation is deteriorating, the level of burden on the economically active population from persons in need of social support (X_{12}) is increasing. These processes are associated with migration and the general situation of human losses in the country. The availability of social protection (X_{13}) during the analyzed period had a tendency to increase. An increase in the social security index indicates the effectiveness of the state's social guarantees. The level of income inequality (X_{14}), according to data from official sources, did not undergo significant changes, the Gini coefficient remained at 25–26% in the analyzed period.

When assessing the institutional resilience of Ukraine, it was found that in 2019–2023, political and legal challenges were the most influential. The quality of public administration (X_5) decreased from 37.9 in 2020–2021 to 32.0 points in 2023. The rule of law index (X_{16}), starting from 2020, has been systematically decreasing. This indicates a loss of judicial independence, which negatively affects the level of trust in formal institutions. The value of the political stability indicator (X_{17}) in the analyzed ranged from the lowest 6.13 in 2022 to the highest, 12.74 in 2021. This indicates a significant impact of the war and the internal political situation in the country on increasing the risks of external and internal political conflicts. The Corruption Perception Index (X_{18}) shows a high but stable value of 30–33 points during 2019–2022. However, in 2023, its increase to 36 points is observed, which indicates a decrease in the effectiveness of anti-corruption measures in Ukraine. In further analysis, to obtain the integral Macroeconomic Resilience Index (*MRI*), the sub-indices were weighted by the values of the corresponding coefficients according to formula (3). The structure of the contribution of each sub-index to the formation of the integral indicator of macroeconomic resilience is shown in Fig. 2.

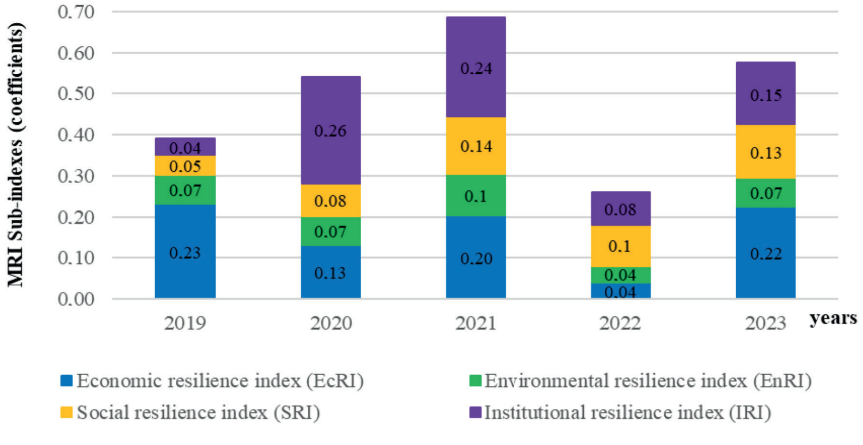

Fig. 2. Structure of the formation of the macroeconomic resilience index (*MRI*) of Ukraine for the period 2019–2023 by weighted sub-indices

The data in Fig. 2 clearly demonstrate the contribution of sub-indices to the formation of the macroeconomic resilience of Ukraine in the period under study. According to the results of our research, it is possible to determine the contribution of individual dimensions of resilience to the formation of the resilience index of the socio-economic system. In 2019, economic resilience (*EcRI*) had the greatest impact, in 2020 – institutional resilience (*IRI*). In 2021, the viability of the macroeconomic system was ensured, first of all, by institutional (*IRI*), and then by economic resilience (*EcRI*). In 2023 – on the contrary, the primacy was given to economic (*EcRI*), then institutional (*IRI*), social (*SRI*) and the least impact was environmental (*EnRI*). In 2022, the viability of the macroeconomics was based on social (*SRI*), institutional resilience (*IRI*), and only then on the equal influence of economic (*EcRI*) and environmental sustainability (*EnRI*).

In addition to the contribution of each sub-index to the formation of the integral indicator of the resilience of the socio-economic system, Fig. 2 clearly demonstrates the uneven development of the socio-economic system of Ukraine in the four areas highlighted by the authors.

The obtained values of the macroeconomic resilience index (*MRI*) during the analyzed period are presented in Fig. 3.

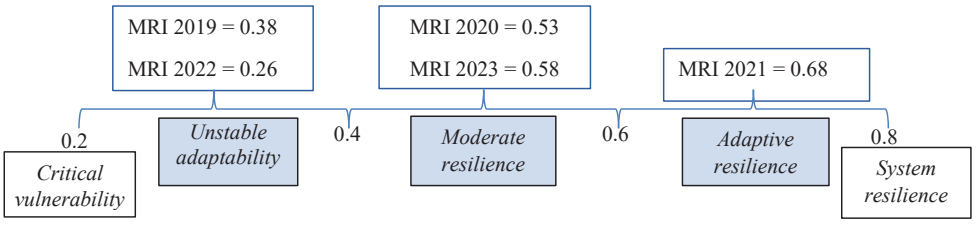

Fig. 3. Macroeconomic Resilience Index (*MRI*) of Ukraine, 2019–2023

Analysis of the Macroeconomic Resilience Index (*MRI*) values obtained during the research indicates fluctuations in the level of macroeconomic resilience in the years under study. As can be seen from Fig. 3, the *MRI* value varies in the range of 0.26–0.68. This means that throughout the entire analyzed period, the Ukrainian economy remains vulnerable to shocks. According to the resilience scale proposed by the authors (Table 1), the macroeconomic system of Ukraine in the period 2019–2023 was in a zone far from systemic resilience.

The analysis of the Macroeconomic Resilience Index values obtained by the researchers in 2019 and 2022 shows that the socio-economic system of Ukraine had the lowest indicators for the studied period, 0.38 and 0.26, respectively, which is characterized as a state of vulnerable resilience. This is due to significant economic shocks, in particular the lockdown and the impact of military aggression, which were reflected in the decline of all components of the resilience of the socio-economic system. In 2020 and 2023, the calculated *MRI* was 0.53 and 0.58 points, respectively, which characterizes the state of moderate resilience of the system, its average vulnerability to shocks. In 2021, the *MRI* reached the highest value for Ukraine (0.68), which is on the resilience scale at the initial level of adaptive resilience. This indicates a relative improvement in the state of the macroeconomic system, in particular due to the positive dynamics of economic growth and improved institutional indicators. However, this level is insufficient for a long-term effect.

The results of the approbation indicate that macroeconomic resilience and its components in all dimensions: economic, social, environmental and institutional, should be a constant focus of management. These conclusions are consistent with scientific research [38], which emphasizes the importance of effective state institutions for laying the foundation for institutional stability and long-term economic growth. As well as the results of [39], where the authors see the vulnerability of the socio-economic system in insufficient diversification of production, weak institutions and significant dependence on imported energy resources, and fluctuations in investment activity [40]. Special emphasis is placed in [40] on supporting small and medium-sized enterprises, as well as a network of industrial parks with favorable conditions and special tax incentives to increase the economic stability of the macroeconomics. To improve the environmental component of macroeconomic resilience [41], the introduction of sustainable technologies for the renewal of transport, logistics and energy infrastructure is proposed, which will ensure a reduction in transportation costs and improved storage conditions for products. State support for the most vulnerable groups of the population under martial law in Ukraine is confirmed by assessments of the effectiveness of social policies in stressful conditions [42]. Also, special attention is required in the areas of regulation of the demographic situation and the state of the labor market.

Summarizing the analysis, it can be stated that increasing the country's macroeconomic resilience is possible if the existing scientific tools are implemented in management practice. Today, the key problems remain structural imbalances between the spheres of economic sustainability, the country's high debt dependence, as well as the growth of environmental and social risks. At the same time, the research results indicate that the use of the Macroeconomic Resilience Index (*MRI*) creates additional opportunities for assessing the current state of the socio-economic system and forming flexible solutions, focusing policies on a specific dimension of resilience, which will contribute to the rapid restoration of the system.

In general, the proposed methodological basis for assessing the resilience of the socio-economic system also has practical significance. The conclusions obtained can be used by state authorities, regional administrations and international institutions to develop macroeconomic resilience policies. The proposed approach allows to track changes in indicators and integral indicators, identify the most vulnerable aspects of the socio-economic system and form priorities for further actions. The developed scientific and methodological approach can be used in further research for scenario planning, development of adaptive macroeconomic strategies, regional development programs.

Despite the complexity of the approach, the research has certain limitations. The determined weights of sub-indexes for assessing the integral index are adapted taking into account the current Ukrainian realities; therefore their application in other countries may require additional correction and mandatory collection of primary data for assessment. To overcome these limitations in subsequent studies, it is necessary to conduct expert assessments of the importance of each component of the resilience dimension (economic, environmental, social and institutional) in the local context according to the standard procedure.

4. Conclusions

1. The proposed resilience scale, constructed using the equidistant step method, establishes the vulnerability limits of the socio-economic system in the range from 0 to 1 with a step of 0.2. The resulting five-step scale allows to identify the following variants of the system state: critical vulnerability (0–0.2); fragile adaptability (0.21–0.4); moderate vulnerability (0.41–0.6); adaptive resilience (0.61–0.8) and systemic resilience (0.81–1.0). The application of this methodological approach to assessing the socio-economic system of Ukraine allows to quantitatively assess its state and identify vulnerable areas of management.

2. An empirical assessment of Ukraine's macroeconomic resilience in 2019–2023 revealed fluctuations in MRI values in the range from 0.26 to 0.68. The highest level of resilience was recorded in 2021 (*MRI* = 0.68), mainly due to the positive dynamics of factors in the economic and institutional sectors. The lowest values were observed in 2019 (*MRI* = 0.38) and 2022 (*MRI* = 0.26), indicating the vulnerable state of the macroeconomic system, caused by quarantine restrictions and large-scale military aggression, respectively, which negatively affected all structural components of the resilience of the socio-economic system.

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3. Component analysis of *MRI* demonstrated the structure of resilience formation during the analyzed period. Economic resilience had a decisive influence in shaping the positive dynamics of the *MRI* integral index in 2019 and 2023. Institutional resilience prevailed in 2020–2021, while social factors of the system's resilience turned out to be the most significant in 2022. Environmental resilience remained the least influential dimension during the studied period. The analysis conducted allowed to determine that the most vulnerable areas for the livelihoods and sustainable development of the socio-economic system of Ukraine are the social and environmental spheres. These results emphasize the need to strengthen management actions in these areas of resilience.

Conflict of interest

The authors declare that they have no conflict of interest in relation to this research, whether financial, personal, authorship, or otherwise, that could affect the research and its results presented in this paper.

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Data availability

The data supporting the findings of this research are available within the article and its supplementary electronic material.

Use of artificial intelligence

The authors state that generative artificial intelligence tools were used exclusively for language editing, grammar checking of the manuscript under full human control. Tool used: ChatGPT (OpenAI GPT-5).

The authors bear full responsibility for the final manuscript.

Declaration submitted by Nataliia Savytska.

Authors' contributions

Nataliia Savytska: Conceptualization, Visualization, Writing – reviewing and editing, Supervision, Project administration; ***Ellina Pakhucha:*** Methodology, Formal analysis, Investigation, Writing – original draft; ***Janina Sawicka:*** Validation, Writing – original draft; ***Kateryna Olinichenko:*** Investigation, Writing – original draft; ***Mariia Mykhailova:*** Investigation, Writing – original draft; ***Andrii Polevych:*** Formal analysis; Data curation, Writing – original draft.

References

1. Barmour, Z., Ahmadi, S., Shokouhyar, S. (2024). Managing supply chain resilience assessment model-relevant factors and activities using an FCM-FBWM approach. *Heliyon, 10 (12),* e32165. https://doi.org/10.1016/j.heliyon.2024.e32165
2. Savytska, N., Zhehus, O., Polevych, K., Prydko, O., Bubenets, I. (2024). Enterprise Resilience Behavioral Management in a Decision Support System. *Journal of Information Technology Management, 16 (4),* 100–121. https://doi.org/10.22059/jitm.2024.99053
3. Savytska, N., Babenko, V., Chmil, H., Priadko, O., Bubenets, I. (2023). Digitalization of Business Development Marketing Tools in the B2C Market. *Journal of Information Technology Management, 15 (1),* 124–134. https://doi.org/10.22059/jitm.2023.90740
4. Pylypenko, A. A., Savytska, N. L., Vaksman, R. V., Uhodnikova, O. I., Schevchenko, V. S. (2019). Methodical maintenance of management of logistic activity of the trade enterprise: Economic and legal support. *Journal of Advanced Research in Law and Economics, 10 (6),* 1723–1731. Available at: https://journals.aserspublishing.eu/jarle/article/view/4943
5. Shtal, T., Proskurnina, N., Savytska, N., Mykhailova, M., Bubenets, I. (2023). Analysis of the Vectors of Digital Transformation of Retail Trade in Ukraine: Determination Methodology and Trends. *Economic Affairs, 68.* https://doi.org/10.46852/0424-2513.2s.2023.42
6. Jollès, M., Meyermans, E., Vašíček, B. (2023). Determinants of macroeconomic resilience in the euro area: An empirical assessment of national policy levers. *Economic Systems, 47 (3),* 101093. https://doi.org/10.1016/j.ecosys.2023.101093
7. Zou, Z., Cheng, C., Song, Z., Wu, X. (2025). Economic resilience of regions within the global supply network in the aftermath of disaster: A case study of Typhoon Mangkhut. *International Journal of Disaster Risk Reduction, 118,* 105275. https://doi.org/10.1016/j.ijdrr.2025.105275
8. Walker, B. H. (2020). Resilience: what it is and is not. *Ecology and Society, 25 (2).* https://doi.org/10.5751/es-11647-250211
9. Zarghami, S., Kaleji, L. K., Abhari, M. (2023). Resilience analysis of the local communities from a political economy perspective in Zanjan, Iran. *Scientific Reports, 13 (1).* https://doi.org/10.1038/s41598-023-46838-x
10. Rezaei Soufi, H., Esfahanipour, A., Akbarpour Shirazi, M. (2022). A quantitative approach for analysis of macroeconomic resilience due to socio-economic shocks. *Socio-Economic Planning Sciences, 79,* 101101. https://doi.org/10.1016/j.seps.2021.101101
11. Martin, R., Sunley, P.; Bristow, G., Healy, A. (Eds.) (2020). Regional economic resilience: evolution and evaluation. *Handbook on Regional Economic Resilience. Vol. 2.* Edward Elgar Publishing, 10–35. Available at: https://ideas.repec.org/h/elg/eechap/16700_2.html
12. Shiozaki, Y., Nagamatsu, S., Sato, K., Bhattacharya, Y. (2024). A systematic literature review of empirical validation of disaster resilience indicators. *International Journal of Disaster Risk Reduction, 111,* 104681. https://doi.org/10.1016/j.ijdrr.2024.104681
13. Bolson, N., Yutkin, M., Rees, W., Patzek, T. (2022). Resilience rankings and trajectories of world's countries. *Ecological Economics, 195,* 107383. https://doi.org/10.1016/j.ecolecon.2022.107383
14. Pileggi, S. F. (2022). Holistic Resilience Index: measuring the expected country resilience to pandemic. *Quality & Quantity, 56 (6),* 4107–4127. https://doi.org/10.1007/s11135-021-01296-3
15. Libanova, E. (2025). Resilience of the Socio-Economic System of Ukraine to the Shocks Caused by the War: Specifics of Formation and Response. *Demography and Social Economy, 4 (58),* 3–23. https://doi.org/10.15407/dse2024.04.003
16. Wu, Y., Zhang, J. (2025). Digital inclusive finance and rural households' economic resilience. *Finance Research Letters, 74,* 106706. https://doi.org/10.1016/j.frl.2024.106706
17. Bertram, L., Schiefeling, M., Kaufmann, R., Korinek, L., Hafele, J. (2024). *Building back better? Economic resilience in the era of the Recovery and Resilience Facility.* ZOE Institute for Future-fit Economies: Cologne. Available at: https://zoe-institut.de/wp-content/uploads/2024/02/Building-Back-Better-economic-resilience-RRF.pdf
18. Pells, Sh. (2023). Resilience – definitions, concepts and measurement. CEU Working Paper 23/02. *Ministry of Business, Innovation & Employment. New Zealand.* Available at: https://www.mbie.govt.nz/dmsdocument/26810-resilience-definitions-concepts-and-measurement-a-literature-review-pdf
19. Beker, T., Aikhenhrin, B., Horodnichenko, Yu., Guriev, S., Johnson, S., Mylovanov, T. et al. (2022). *A Blueprint for the Reconstruction of Ukraine.* London: Centre for Economic Policy Research Press. Available at: https://cepr.org/system/files/publication-files/147614-a_blueprint_for_the_reconstruction_of_ukraine.pdf
20. Schwark, F., Tryphonides, A. (2025). Technical change and macroeconomic resilience to sectoral shock. *Economics Letters, 246.* https://doi.org/10.1016/j.econlet.2024.112077
21. Kuhn, M., Luo, J., Manovskii, I., Qiu, X. (2023). Coordinated firm-level work processes and macroeconomic resilience. *Journal of Monetary Economics, 137,* 107–127. https://doi.org/10.1016/j.jmoneco.2023.05.001
22. GHG emissions of all world countries (2024). *European Commission.* Available at: https://edgar.jrc.ec.europa.eu/report_2024
23. *Ukraine's Greenhouse Gas Inventory 1990–2023* (2025). Kyiv. Available at: https://mepr.gov.ua/wp-content/uploads/2025/03/Ukraine_NID_2025.pdf
24. *FAOSTAT* (2023). Available at: https://www.fao.org/faostat/en/#country/230
25. Country Trends. *Global Footprint Network*. Available at: https://data.footprintnetwork.org/#/countryTrends?cn=230&type=BCpc,EFCpc
26. All Country Scores (2023). *Index of Economic Freedom.* Available at: https://www.heritage.org/index/pages/all-country-scores
27. Kaufmann, D., Kraay, A. (2024). The Worldwide Governance Indicators: Methodology and 2024 Update. *World Bank Policy Research Working Paper No. 10952.* Available at: https://documents1.worldbank.org/curated/en/099005210162424110/pdf/IDU-7c6f0b9e-f0c2-4b1d-b30d-76c4644af69e.pdf
28. *National Bank of Ukraine.* Available at: https://bank.gov.ua/en/statistic/sector-external
29. Macroeconomic Indicators (2024). *Statistics. National Bank of Ukraine.* Available at: https://bank.gov.ua/ua/statistic/macro-indicators
30. Ekonomika Ukrainy. *Minfin.* Available at: https://index.minfin.com.ua/ua/economy
31. *Demohrafichnyi prohnoz po Ukraini 2024.* Available at: https://www.demography.org.ua/

32. AlTi Global Social Progress Index (2025). *Social Progress Imperative.* Available at: https://www.socialprogress.org/alti-global-social-progress-index
33. Unemployment rate. *International Monetary Fund.* Available at: https://www.imf.org/external/datamapper/LUR@WEO/UKR
34. Corruption Perceptions Index 2024. *Transparency International.* Available at: https://www.transparency.org/en/cpi/2024/index/ukr
35. Gini index. *World Bank Group.* Available at: https://data.worldbank.org/indicator/SI.POV.GINI
36. Worldwide Governance Indicators. *World Bank Group.* Available at: https://www.worldbank.org/en/publication/worldwide-governance-indicators
37. Basanets, O. (2024). Naibilshe dehradatsiia zemel proiavliaietsia v hospodarstvakh z zembankom ponad 5 tys.ha. *SuperAgronom.* Available at: https://superagronom.com/news/18312-naybilshe-degradatsiya-zemel-proyavlyayetsya-v-gospodarstvah-z-zembankom-ponad-5-tis-ga
38. Hvelesiani, A. H., Chernichenko, V. V. (2023). The Review of Approaches to Definition the Concept and Indicators of Socio-Economic Systems Resilience: International Experience. *Statistics of Ukraine, 102 (3-4),* 4–15. https://doi.org/10.31767/10.31767/su.3-4(102-103)2023.03-04.01
39. Khaustova, V. Ye., Reshetnyak, O. I. (2023). Resilience of Economy: Its Essence and Challenges for Ukraine. *Business Inform, 7 (546),* 30–41. https://doi.org/10.32983/2222-4459-2023-7-30-41
40. Pakhucha, E., Sievidova, I., Romaniuk, I., Bilousko, T., Tkachenko, S., Diadin, A., Babko, N. (2023). Investigating the Impact of Structural Changes: The Socio-Economic Security Framework. *European Journal of Sustainable Development, 12 (1),* 180–198. https://doi.org/10.14207/ejsd.2023.v12n1p180
41. Sachs, J., Schmidt-Traub, G., Kroll, C., Lafortune, G., Fuller, G., Woelm, F. (2022). Sustainable Development Report 2022. From Crisis to Sustainable Development: the SDGs as Roadmap to 2030 and Beyond. *Includes the SDG Index and Dashboards.* Cambridge University Press. https://doi.org/10.1017/9781009210058
42. *OECD Economic Outlook* (2023). Paris: OECD Publishing, 2 (114). https://doi.org/10.1787/7a5f73ce-en

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